Energy & Resources 291-03 Spring 2007
Prof. Gadgil

Poverty Reduction in Panama

Reducing the use of disposable batteries in a Ngöbe village

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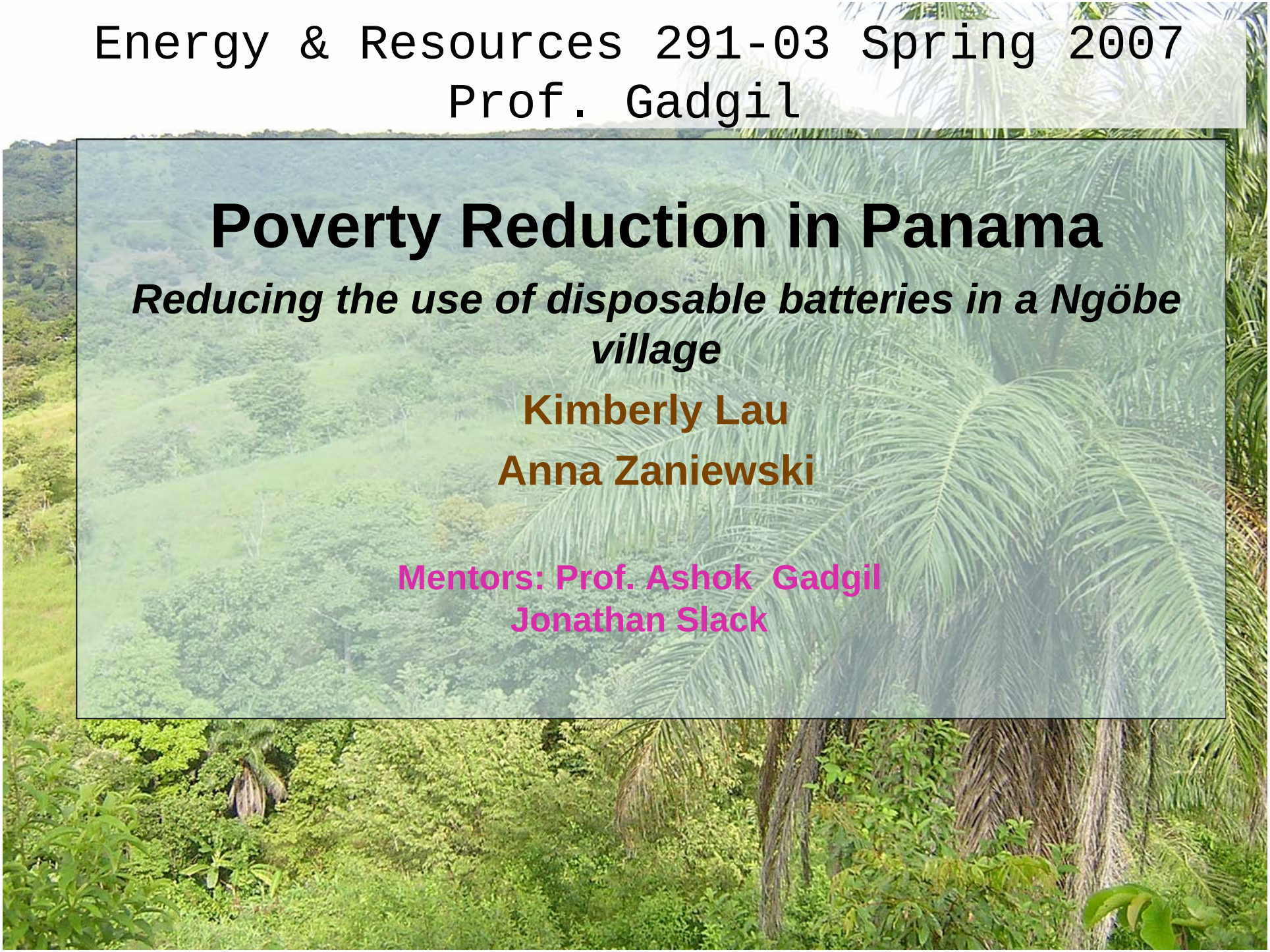


The Problem

The Global Problem: Lack of Access to Electricity

- 25% of the world (1.6 Billion People) lives without electricity
- 4 out of 5 of people without electricity live in rural areas in the developing world.
- Electricity is useful: reduces cost of living, increases literacy, standard of living
- Building electricity generation facilities and electricity grids is capital-intensive, especially for dispersed populations
- Centralized systems are thus ill equipped to provide services to the rural poor.

Global Problem, Local Focus

- Focusing on Soloy, Panama, in the Ngöbe-Bugle Comarca

The lessons learned here may also be applicable to other communities.

Soloy and The Ngöbe People

The Ngöbe of Panama have long been a marginalized ethnic group, on the fringe of national culture, they are among the poorest in Panama.

*Income sources include agriculture, migrant labor, crafts

*Soloy is a good starting point for any campaign in the Ngöbe Comarca, as it is (relatively) easily accessed, and there is a solar powered internet lab at the school, and a radio station.

*These infrastructure represent the best infrastructure to be found in the Comarca.

Flashlight Usage in Soloy

- Pilot survey to English students also reveals that flashlights are used for:
  - Walking at night - Working
  - Cooking - Getting Water
  - Reading - Visiting patients (midwife)
- Students showed unanimous interest in having flashlights with increased efficiency
- Know from personal experience that LED light is sufficient for traveling at night in Soloy

Goals

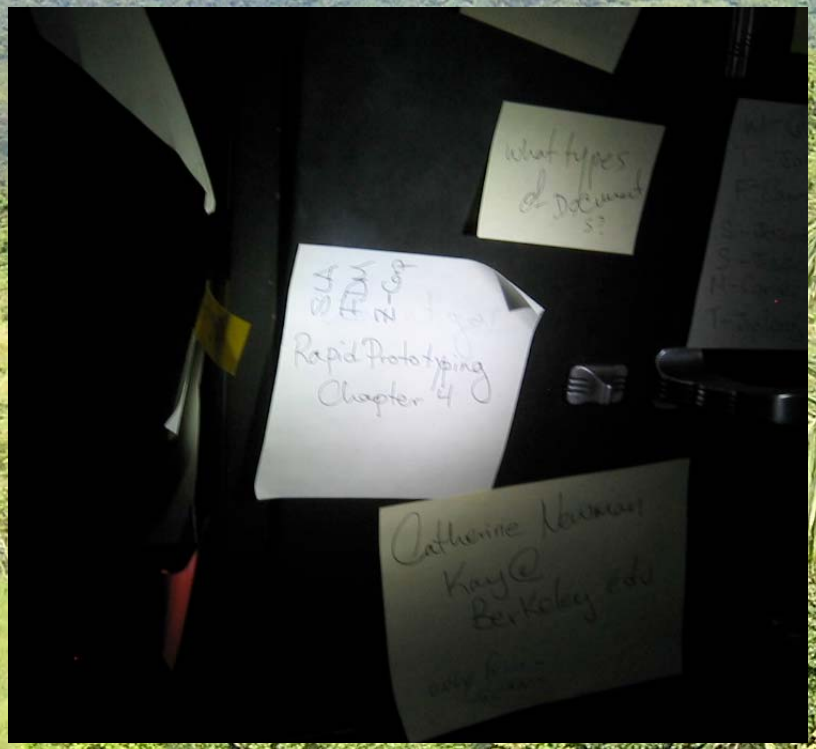
- Develop prototypes of LED retrofitted flashlights and maximize design with respect to user needs
- Identify financially viable means of distribution of LED retrofits
- Design specifications of retrofit kit
- Performance analysis of battery lifetime with LED flashlight
- Economic analysis with models of distribution
- Pilot test of prototypes
- A manual on how to retrofit flashlights; pilot test the manual

LED Flashlights Retrofit

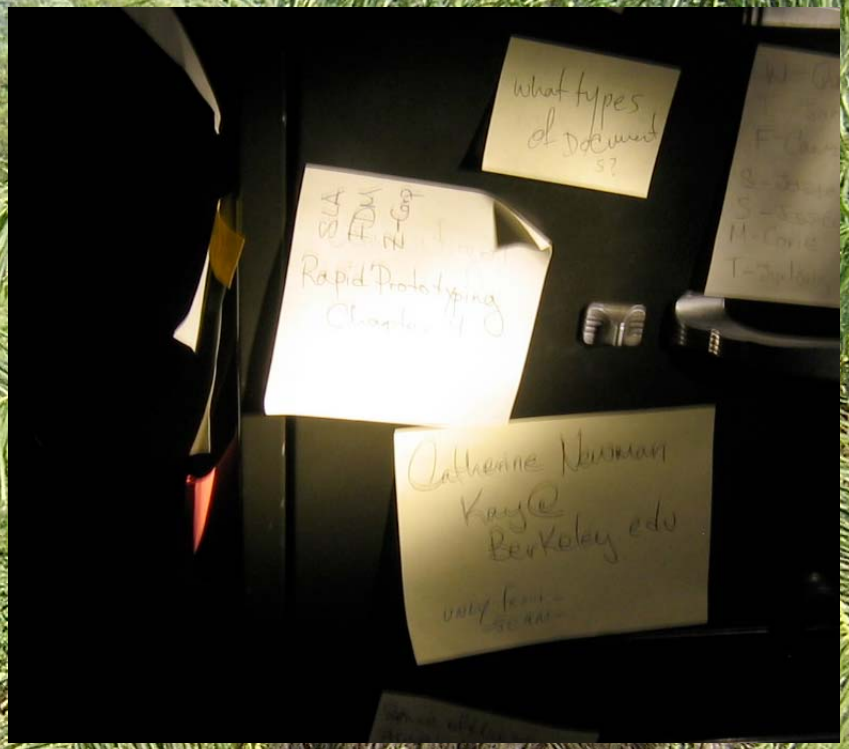
LEDs have efficiencies of ~25-75 lumens/Watt, compared to ~5 lumens/Watt for small incandescent bulbs!

- Benefits
  - Increased efficiency of lightbulbs
  - Reduced amount of light output
  - Higher charge capacity at lower current draw of batteries
- Why retrofit:
  - On-site construction of product reduces price and allows for entrepreneurial opportunities
  - Using LED retrofitted flashlights is simple and does not require learning new technology or changing habits.
  - D cells have the most charge capacity/$ making D cell-based flashlights the most cost efficient in the long run

Light Comparison



2-LED bulbs



Incandescent bulb

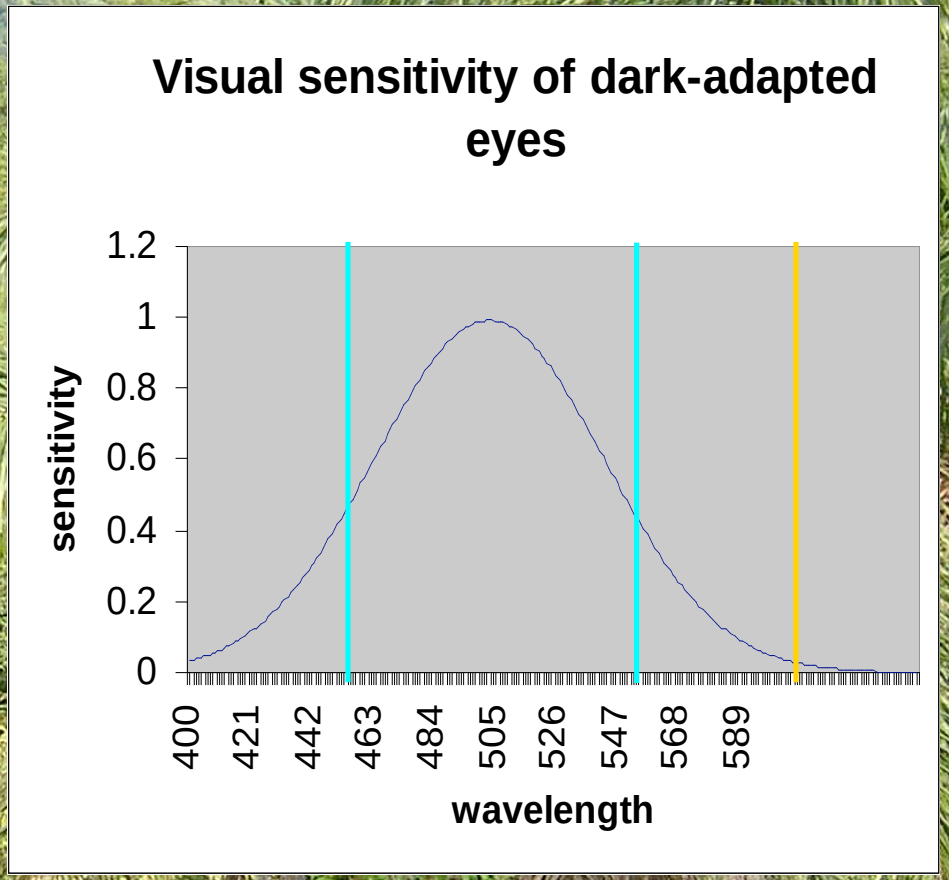
Light Comparison

2-LED bulbs

Incandescent bulb

- Incandescent light much brighter… to some extent too bright
- Safer to preserve night vision by using a dimmer light – makes you more aware of surroundings

White LEDs output light at 2 peak wavelengths, which are both closer to the human sensitivity peak than the peak wavelength of the incandescent

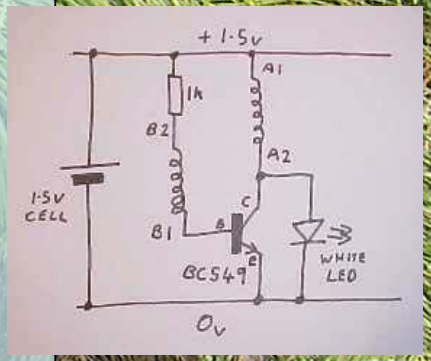


Final Design

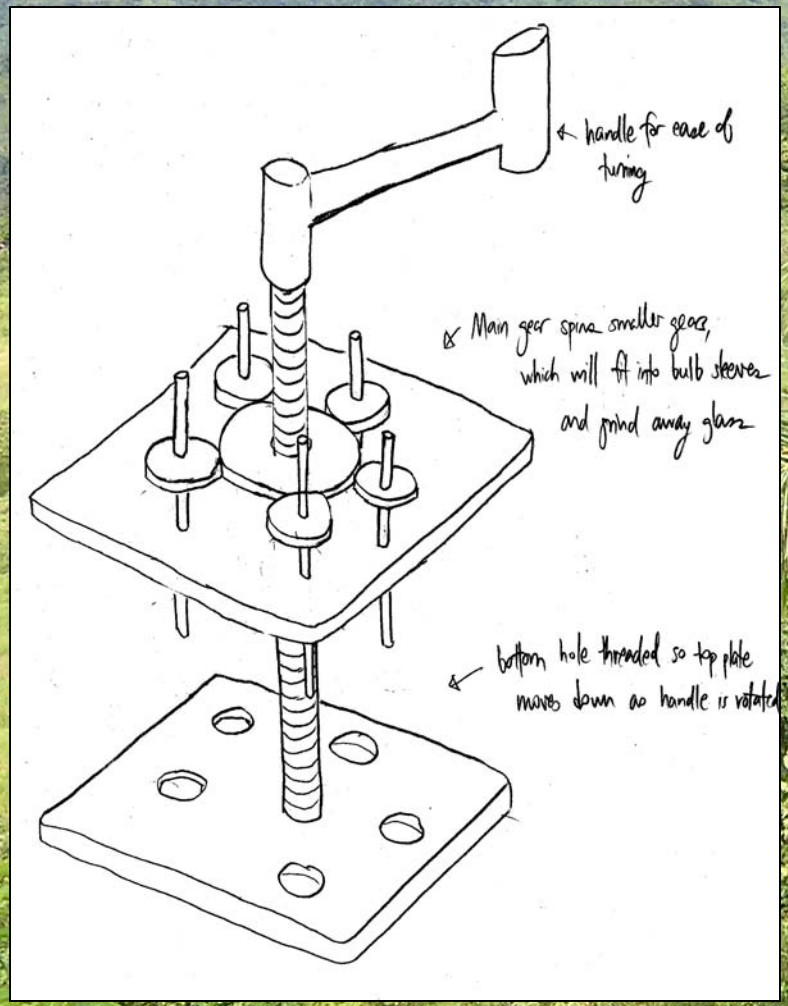
- 2 LED-bulb flashlight
  - Incandescent bulb removed and replaced with LED bulbs
  - Soldered directly into bulb sleeve

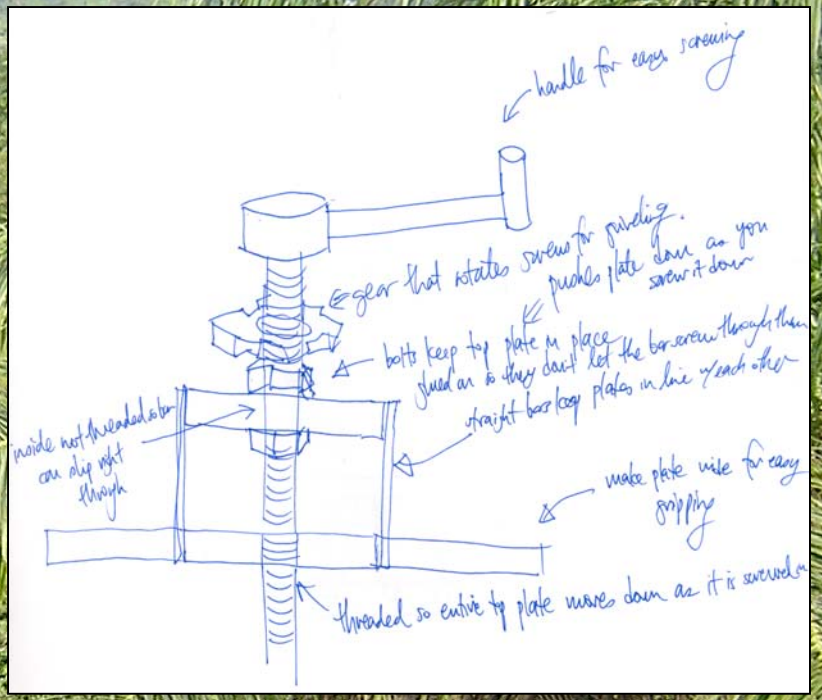
Rejected Designs

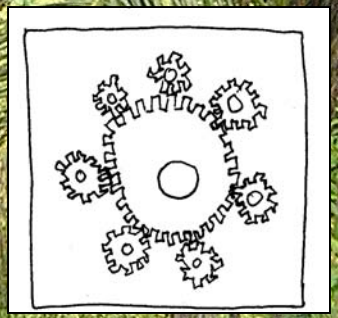
- 3-LED bulb flashlight
  - Light tests did not show significant improvements in light quality for 3-LED bulbs
- Joule thief circuit
  - Too complicated to build and fit into the bulb sleeve
- Power conditioning circuit from National Semiconductor
  - Intricate wiring from each LED bulb to circuit board required
  - Potential for unequal power output LEDs

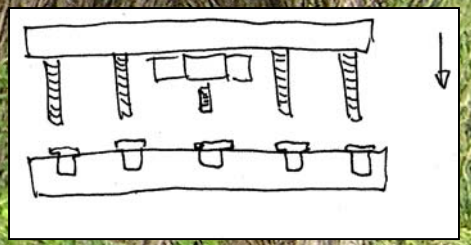


Bulb Crusher 2000

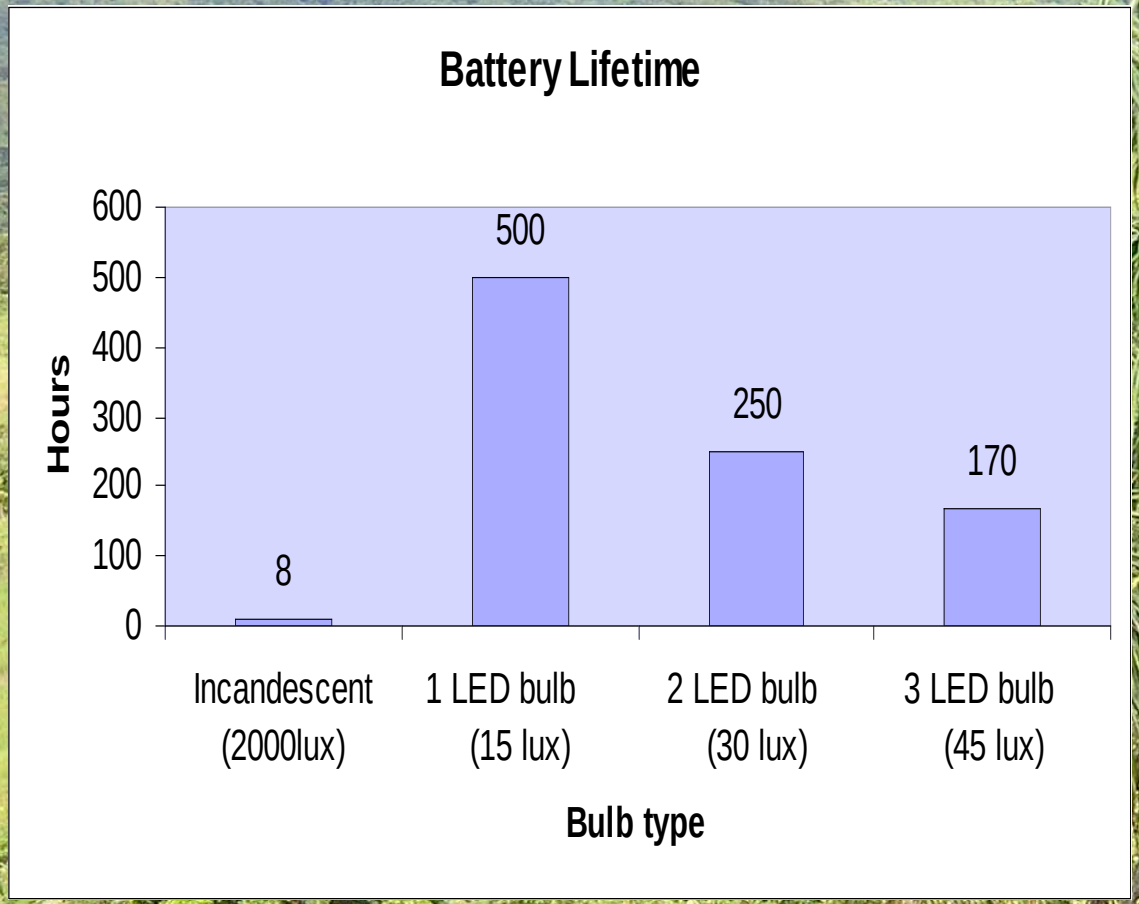








LED possibilities



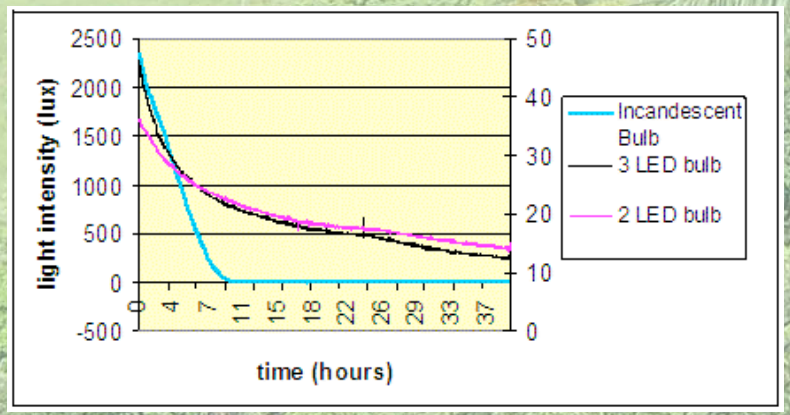
- Data to left are for standard low power white LEDs.
- Eye responds logarithmically to light, so a factor of 40 difference in light output is seen as a factor of 1.6 difference.

Light Output Test Results

Flashlights were left on continuously- not a good approximation to actual use.

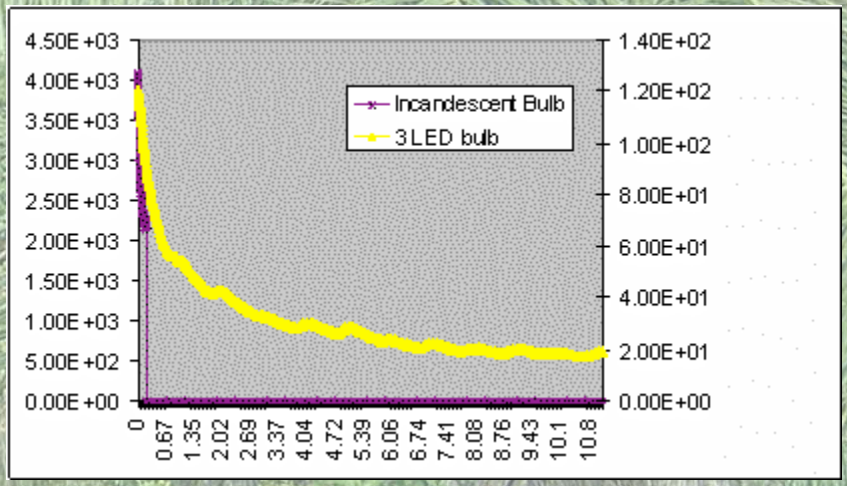
Light Intensity vs Time (hours)

Carbon-Zinc Batteries



Light Intensity vs Time (days)

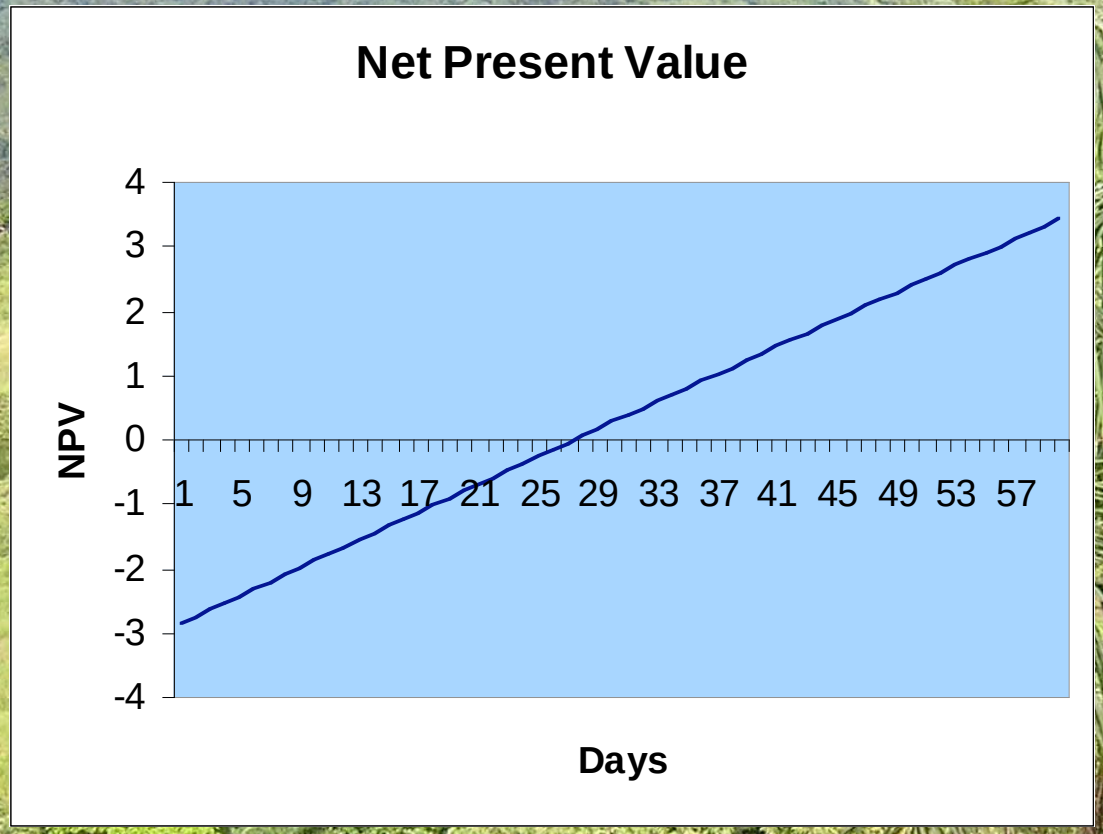
Alkaline Batteries



Pilot Testing of Flashlight

- Anna took a 2 LED bulb flashlight with her camping to Big Sur. It worked nicely for walking around at night and playing cards.
- We sent 3 prototypes to a family in Soloy. They have been using them to the exclusion of their other flashlights and say that they like them.

Payback!



Payback time is so fast the curve is nearly linear!

***Assumed 50% annual discount rate**

***Break even at 27 hours**

Financial Feasibility of Project

Number produced	2 white LEDs	Solder	Batteries for Soldering Iron	Labor	Cost/ unit	Total Cost
100	$2.30	.01	.03	.25	$2.59	$279
1000	$1.30	.01	.03	.25	$1.59	$1610

- **Startup (one time) costs**
  - **Battery powered soldering iron: $20**
- **End price to user should be $2.50 to $4**
- **Current flashlight costs in Soloy**
  - **Incandescent light: $1-$2**
  - **A pair of batteries: $1-$1.50**

Fiscal Analysis

- Each retrofit saves each family at least $63/year in battery expenses
- Employing 1000 retrofits would put $63,000 back people living in poverty
- In the future, we hope to bring our project to other villages and implement similar programs in the Comarca
  - This means replacing 50,000 incandescent bulbs with a net savings of $3,150,000!

Entrepreneurial and Empowerment Opportunities

- Project is not just about new flashlight bulbs; it's about empowerment through technology
- Local manufacture: our goal is to train locals to produce the retrofits
- Women's group has expressed an interest in being involved.
- The women then have a new income source and the community is less dependent upon imported batteries.

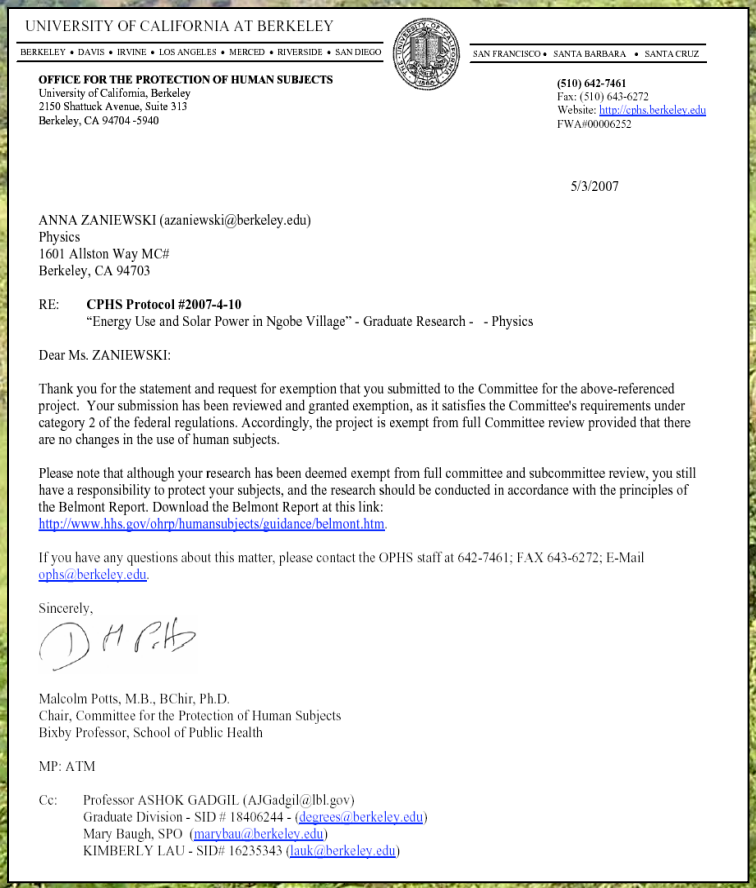
Environmental Impact

- Soloy has no official waste disposal facility
  - Batteries are thrown into the river, burned, buried in the land
- Retrofit means 30 times fewer batteries are being used
  - Reduces heavy metal contamination of water
  - Reduces safety hazards associated with burning batteries

Possible Dissemination Strategies

- Radio advertisements
- Workshops
  - Teach flashlight retrofit process in classes
  - Familiarize locals with rechargeable batteries and recharging process
  - Free movie with flashlight teach-in
- Spread knowledge and benefits of retrofit through Opinion-Leaders
- Involvement of local NGOs

Committee to Protect Human Subjects



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5/3/2007

ANNA ZANIEWSKI (azaniewski@berkeley.edu)
Physics
1601 Allston Way MC#
Berkeley, CA 94703

RE: **CPHS Protocol #2007-4-10**
"Energy Use and Solar Power in Ngobe Village" - Graduate Research - - Physics

Dear Ms. ZANIEWSKI:

Thank you for the statement and request for exemption that you submitted to the Committee for the above-referenced project. Your submission has been reviewed and granted exemption, as it satisfies the Committee's requirements under category 2 of the federal regulations. Accordingly, the project is exempt from full Committee review provided that there are no changes in the use of human subjects.

Please note that although your research has been deemed exempt from full committee and subcommittee review, you still have a responsibility to protect your subjects, and the research should be conducted in accordance with the principles of the Belmont Report. Download the Belmont Report at this link:
http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.htm.

If you have any questions about this matter, please contact the OPHS staff at 642-7461; FAX 643-6272; E-Mail ophs@berkeley.edu.

Sincerely,

Malcolm Potts, M.B., BChir, Ph.D.
Chair, Committee for the Protection of Human Subjects
Bixby Professor, School of Public Health

MP: ATM

Cc: Professor ASHOK GADGIL (AJGadgil@lbl.gov)
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Mary Baugh, SPO (marybau@berkeley.edu)
KIMBERLY LAU - SID# 16235343 (lauk@berkeley.edu)

- Exemption granted by CPHS!
- Survey begun in Soloy
  - Target 15% of households (60 families) in 20 neighborhoods
  - 30 questions
  - Administered by locals using random walk method

New Member Recruits

We have recruited 2 new students to our team as well as a business advisor:

- Noelle Cole is a city planning grad student who will help us develop a marketing strategy
- Jed Deursch is a physics grad student who is helping us with some of the technical aspects of the project
- Sara Beckman is a UC Berkeley professor and a member of the Haas Operations and Information Technology Management Group. Her research interests include innovation and design management, new product development, operations strategy, and environmental supply chain management. She serves as the business mentor for this project.

Method of Evaluations

- Analysis of survey results
  - How many people willing to purchase and use product?
- Test prototype locally in actual nighttime environment
  - Gather initial reactions to product
- In future, more numerical results will be available
  - # products sold
  - # businesses opened
  - # families using the product
- In coming months, survey again how users have become acclimated to the product as well as calculating their actual savings.

Travel Plans

- To Soloy this summer!
- Goals
  - Retrofitted flashlights
    - Introduce all the prototypes to locals
    - Perform tests to determine which models work best and are most preferred and successful amongst locals
    - Teach locals how to retrofit the flashlights themselves
  - Solar Panels
    - Visit families with solar panels and document solar panel set up
    - Investigate reason for the failure of the solar panel project

Solar Panels in Soloy

A pilot survey to English students revealed a failed project of introducing solar panels to the community

- Project donated 80 solar panels to various families, but many panels are no longer functional because the families cannot afford to maintain them.
- Another case of first world high tech going to waste in the third world!

We focused on flashlight retrofits this semester, but we will be doing a complete survey of solar panels so future students can capitalize on this opportunity

Lessons Learned

- Discarded Ideas
  - Treadle-Powered Generator
  - Human-Crank-Powered Flashlights
  - Shaking-Powered Flashlights
- Proceeding with simple and effective projects are much better than extravagant projects that locals will not adapt to

Conclusions

- Retrofits are successful and highly efficient
- Lab tests show batteries last longer with LEDs
- This technology is liked and wanted by locals
- To Soloy this summer to introduce and hopefully establish new, efficient technologies!

Acknowledgements

- Blum Center
- George Scharffenberger
- Ashok Gadgil
- Jonathan Slack
- Howdy Goudey
- Susan Amrose